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A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

Attention and memory functioning in adult persons with the appearance of hyperactivity disorders

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SUMMARY

Background: Until recently, hyperactivity disorders have been associated mainly with a growth period. It is more often stressed, however, that many persons do not grow out of ADHD but become adults with persistent disorders. This research aimed at answering the question of the differences in the attention and memory functioning in adults with hyperactivity symptoms in comparison to persons without ADHD symptoms.

Material/ Methods: Two groups of adults took part in the research: a group with ADHD symptoms and no other diagnosed disorders (N=34) and a control group without hyperactivity symptoms or other disorders (N=32). We used: a behaviour questionnaire – an experimental version, the Attention and Perceptiveness Test, the Trail Making Test A&B, the Digit Span and Digit Symbol WAIS-R subtests (Polish standardization), the d2 Test of Attention, and the Benton Visual Retention Test.

Results: The results of the analysis showed a lower ability in perceptive field search and a lower ability to focus attention, a worse functioning of working memory and deficits in psychomotor speed in the group with ADHD symptoms in comparison to the control group. There was no difference between the groups, however, regarding the ability to switch to a new criterion for response.

Conclusions: It was revealed, that persons with an ADHD function were worse in regard to visual and auditory working memory in comparison to those persons without ADHD symptoms. A reduced ability to focus attention was shown, though these difficulties were visible mainly in the progress speed and not in performance efficacy. The assumptions about difficulties in switching to a new response criterion among persons with hyperactivity disorder symptoms were not confirmed.

Keywords: ADHD, hyperactivity, working memory, attention

INTRODUCTION

ADHD is associated mainly with childhood and the period of adolescence. Nevertheless, the statistics show, that 30%-85% of people do not 'grow out of' ADHD and reach adulthood still struggling with the disorder and its results such as secondary difficulties (Barkley, 1998; Driggs, 1995; Seidman, 2006; Clark et al., 2007).

Experts tend to apply towards adults the classification criteria common for the diagnosis of children . These are not sufficient, however, in all cases (Wolf and Wasserstein, 2001; Bowes, 2001). Thus, the attempts at creating systems aimed at ADHD diagnosis after the adolescent period have been made. Hallowell and Ratey (2004) suggested diagnostic criteria for adults with ADHD based on the following three guidelines: symptoms related to the triad-attention deficit-impulsiveness-hyperactivity, childhood ADHD (not necessarily diagnosed) and the lack of other explanations of symptoms in medical terms (cf. the Utah criteria, Wender, 2000).

According to ICD-10 (1992), hyperkinetic disorders are characterized by an early onset, the coexistence of hyperactivity and inappropriate conduct with an apparent lack of attention and persistence in task. It should be mentioned that these disorders emerge in every situation and are of a chronic kind. According to the research results, about 90% of adults suffering from persistent ADHD are characterized by attention deficits in the first place, whereas only 50% of adults with ADHD have prominent symptoms connected with motor hyperactivity or impulsiveness (Millstein et al., 1997; Marchetta et al., 2008). Depending on the constellation of prominent symptoms , in a way similar to children (Borkowska, 2008), there appear various difficulties in respect of behaviour and emotional or social competence within adults (Ratey et al., 1992; Friedman & Rapport, 2003; Kalka & Richert 2008).

In relation to these facts, a number of authors have indicated that attention deficits are the basic criterion for hyperkinetic disorder (ADHD) diagnosis among adults (e.g. Marchetta et al., 2008; Millstein et al., 1997). More often this group is examined mainly in terms of the specificity of attention disorders.

Attention deficits among adults with ADHD concern a few of its aspects. They are characterized by difficulties in the choice of one stimulus out of many, problems with the active search for the needed stimulus, problems with focusing attention on a single activity, focusing attention on a few stimuli as well as attention shiftability (Walsh, 1998). Hollingsworth, McAuliffe and Knowlton (2001) showed in their research that in adults with ADHD, automatic orientation attention remains intact, whereas serious deficits concern the attention executive mechanism connected with its allocation. In order to indicate the areas of poorer functioning of attention in adults with ADHD, there have been conducted researches through the applying of ANT. This method enables research on the three attention systems distinguished by Posner (1995): orienting, alertness and executive. The results of the research carried out in a group of children with psychomotor hyperactivity (Mullane et al., 2010) show that attention disorders in this group concern the executive and alertness mechanism. In the aforementioned research, children with ADHD could not omit the distracting context, i.e., the distractive information activating an incorrect response. Moreover, only when the exposition was announced with a sound, did the responses of the hyperactive children d not differ in terms of speed when compared to the healthy children. This means that initially they were not prepared to perform a task in the same way and needed a warning signal. In the research conducted with the use of the same method in a group of adults with ADHD (Lundervolt et al., 2011) it was shown that the alertness and executive systems functioned worse only in the case of persons who apart from hyperactivity symptoms were additionally characterized by mood disturbances. It was also observed that all persons from the criterion group demonstrated a generally lower correctness level in task completion as well as difficulties in permanent attention focus. Apart from the problem with permanent attention focus, which was repeatedly confirmed by the research results, it has been also underlined that persons with ADHD symptoms show difficulties in refraining from an undesirable reaction. In the task regarding a reaction to a particular sequence of letters and refraining from reacting to other letter patterns, persons with ADHD needed more time to complete this task, made more omission errors, showed greater dispersion in reaction time and more often gave in to the misleading context in the perceptive field. According to the authors, the inability to effectively sustain attention and inhibit response is the basis for many of the cognitive deficits observed in persons with hyperactivity. Similar conclusions were drawn by the authors applying other research methods. Avisar and Shalev (2011) examined the ability to sustain attention and inhibit response by displaying colourful geometric shapes with a request for a response to a definite pattern only (e.g. a red square). The authors have indicated difficulties in terms of response inhibition (more false alarms) and sustaining attention, as well as more omission errors and a big dispersion of the whole series of exposition results. In the case of persons with ADHD, the longer time for the completion of tasks engaging attention results from the fact that they do not make the right selection of the stimuli in terms of validity (Tucha et al., 2008), which may in turn may represent a problem with searching for stimuli important in the perceptive field. Research on tracking eye movement (Munoz et al., 2003) has shown that adults with ADHD have problems with its control and often fix eyes on the wrong, in terms of target, spots.

Adults with hyperactivity, apart from problems with various attention functions, demonstrate also problems with working memory functioning (Clark et al., 2007). These kind of deficits are well substantiated in the case of children and adolescents with ADHD (Martinussen et al., 2005; Willcutt et al., 2005; Pachalska et al., 2012). These deficits concern both verbal and non-verbal working memory. Numerous reports indicate that the same deficits may concern adults suffering from persistent psychomotor hyperactivity (Boonstra et al., 2005; Dowson et al., 2004). The research on spatial working memory as a system of instantaneous maintenance and manipulation of visual information (Young et al., 2006) showed that people with ADHD demonstrate deficits in this field, ones which intensify together with an increase in task difficulty. Schweitzer, Hanford and Medoff (2006) applied two ways of examining working memory. The ability to maintain the information in mind was examined by the Digit Span subtest from the Wechsler Adult Intelligence Scale, while the ability to manipulate this information was explored with the PASAT Test. In both researches persons with ADHD obtained lower results in comparison to the control group. In the Digit Span subtest, which examines working auditory memory, adults with ADHD performed worse both in tasks requiring forward and backwards repeating (Burgess et al., 2010). Problems with direct auditory memory are confirmed, among others, by the results of tests conducted by Marchetta et al., (2008). The authors examined working memory with the use of the presentation of monosyllabic words to be reconstructed immediately (after listening) and after 20 minutes. The differences regarding correctness between the group of people with ADHD and the control group could be traced in terms of recent memory. The authors compared the groups also in respect of such executive functions as distraction control (Stroop Test) or the ability to switch between tasks (Trial Making Test A&B). In each of these tasks persons with ADHD performed poorer than healthy persons. These results confirm the empirical reports by Miller, Ho and Hinshaw (2012), who conducted longitudinal research in a group of girls with ADHD symptoms diagnosed in childhood. The authors showed persistent deficits in terms of response inhibition and sustaining attention, as well as auditory working memory, which was measured by the Digit Span subtest of the WAIS-II Test and in terms of the ability to switch between tasks, which was measured by the Trail Making Test.

MATERIAL AND METHODS

The following methods were used in this research: a Behaviour questionnaire – an experimental version (Kalka, 2005), the Attention and Perceptiveness Test (Ciechanowicz and Stańczak, 2006), the Trail Making Test A&B (Kądzielawa et al 1987), Digit Span and Digit Symbol WAIS-R subtests (Polish standardization) (Brzeziński et al., 2004), the d2 Test of Attention-standard version (Brickenkamp, 1994), Benton Visual Retention Test (Jaworowska, 2007).

Two groups took part in the research: criterion (N=34) and control (N=32). The first group consisted of adults with ADHD with no other diagnosed disorders. They were all family members (parents or older siblings) of school-age children with diagnosed ADHD. Some older siblings had been diagnosed with hyperactivity in their adolescence period. The presence of ADHD symptoms was verified by the Behaviour questionnaire – an experimental version (Kalka, 2005). There were 24 women and 10 men examined in this group with an average age of 27.2 (SD= 7.63). The control group consisted of persons without hyperactivity symptoms or other disorders. It consisted of 21 women and 11 men with an average age of 26.6 (SD=5.28).

The research was anonymous and voluntary.

RESULTS

In order to verify whether adults with hyperactivity symptoms differ in terms of the ability to search a perceptive field by tracing stimuli meeting definite criteria, an analysis of the results obtained in the d2 Test and the Attention and Perceptiveness Test was carried out. Both tests are used to examine attention competence in respect of searching and selecting. The tests contain slightly different graphic elements and an indication of which of these elements serve as signals to which a response is required. Additionally, the d2 Test gives information regarding the ability to focus attention. The Attention and Perceptiveness Test showed differences between the groups in terms of the number of checked elements in a limited time of 3 minutes [$t(2,64)=4.78$; $p<0.001$]. Persons with ADHD symptoms managed to check in the same time fewer ($M=378.47$) elements than the control ($M=507.59$), which is presented in the graph below.

There were no differences between groups in terms of the number of mistakes made, both in the case of false alarms as well as omissions. Similar results, in terms of checked elements, were obtained in the d2 Test. Persons with ADHD symptoms managed to check significantly fewer elements ($M=459.88$) than persons from the control group ($M=534.81$); [$t(2.64) = 4.25$; $p<0.001$], there was no difference in the total number of mistakes made (Fig. 1). The d2 Test enables one to determine the level of ability to concentrate, defined by the difference between the total number of checked elements and mistakes such as false alarms. It turned out to be the index, which substantially differentiates the two compared groups [$t(2.64)=3.83$; $p<0.001$]. The group of persons with hyperactivity symptoms showed a substantially lower ability to concentrate ($M=177.5$) than the control group ($M=217.25$). By comparing this index it can be shown that persons from the criterion group make relatively more mistakes in reference to the number of total checked elements.

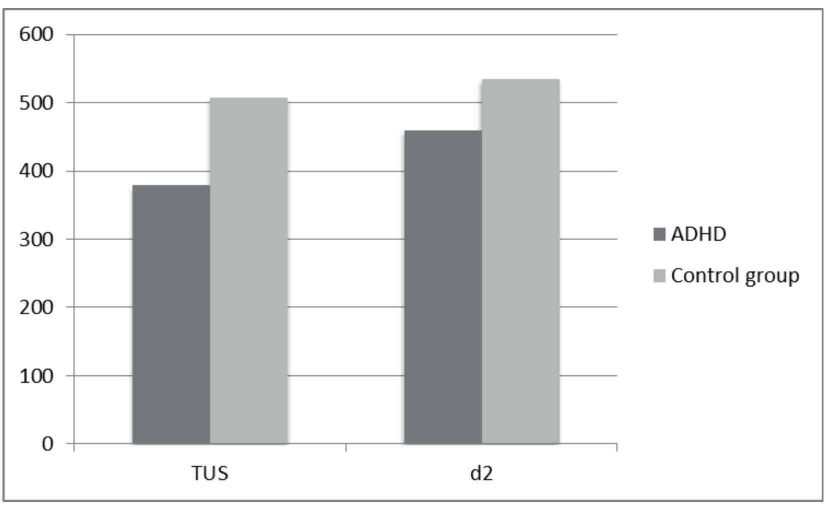

Fig. 1. Comparison of average test results: d2 Test and Attention and Perceptiveness Test

In order to verify whether the examined groups differ in terms of auditory working (mechanical) memory functioning, the results of the Digit Span subtest were compared. It was revealed that persons from the group with ADHD symptoms correctly reconstructed significantly less test material (M=10.59) than persons from the control group (M=13.28); [t (2.64)=3.84, p< 0.001] (Fig. 2). Visual working memory functioning was examined with the use of the Benton Visual Retention Test. It was shown that persons with hyperactivity symptoms reproduce less plates correctly (M=5.53) than the control group (M=7.19); [t(2.64) = 5.15; p<0.001] (Fig. 2) and make more mistakes in reproduction (M=6.15) than persons from the control group (M=3.69); [t(2.64)=5.0; p<0.001].

Similarly, a significantly weaker functioning of direct visual memory in combination with visual-motor learning pace was proved with the use of the Digit Symbol subtest in the group of persons with ADHD symptoms (M=56.85) in comparison to the control group (M=69.16); [t(2.62)=5.55; p<0.001] (Fig. 3).

In addition, owing to the application of the Trail Making Test A&B, it was possible to examine differences in psychomotor speed and working visual-spatial memory, as well as the ability to switch to a new criterion for response. The obtained results revealed that in terms of psychomotor speed (Trail Making Test version A), persons with ADHD symptoms differ substantially from those without such symptoms [t(2.64)=4.8; p<0.001]. This task was performed substantially longer by the criterion group (M=40.15) than the control group (M=25.16) (Fig.4). The groups did not differ in terms of the number of mistakes made while connecting the digits. Examining the visual-spatial operational memory (Trail Making Test version B), a statistically essential difference between the examined groups was found during task performance [t(2.64)=3.207; p<0.001]. Persons with ADHD symptoms carried out this part of the research significantly longer (M=78.62) than healthy persons (M=53.62) (Fig. 4). Statistically significant dif-

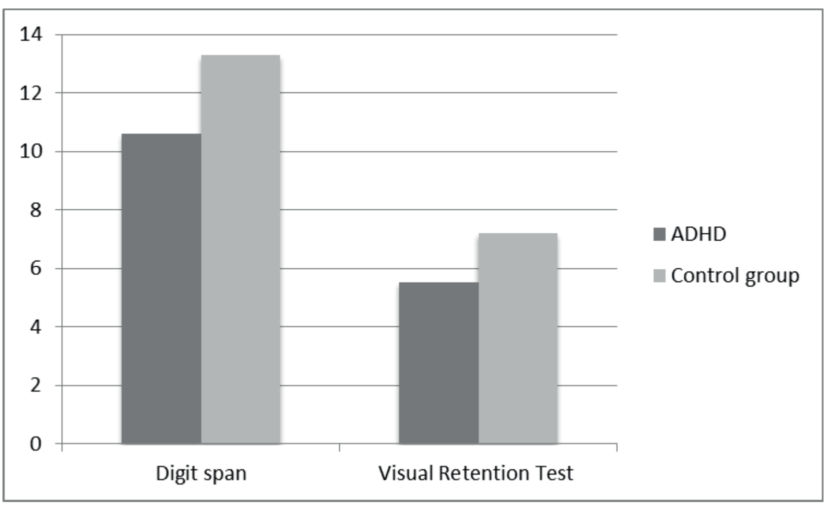

Fig. 2. Comparison of average test results: Digit Span and Visual Retention Test

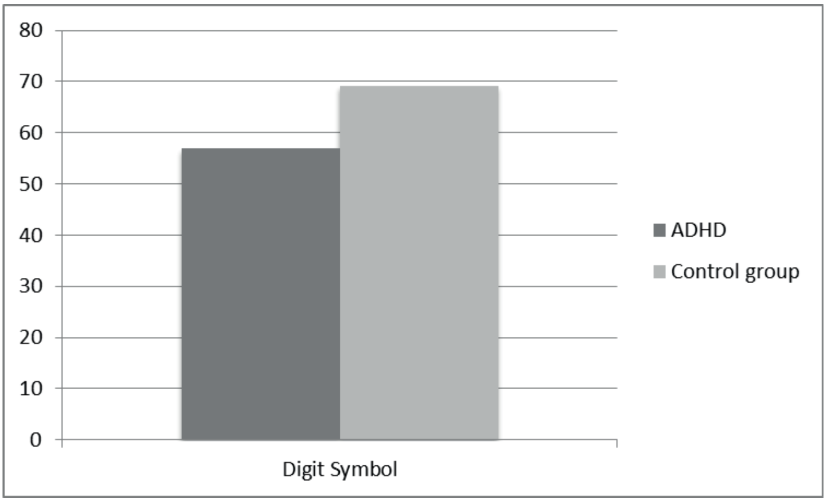

Fig. 3. Comparison of average test results: Digit Symbol

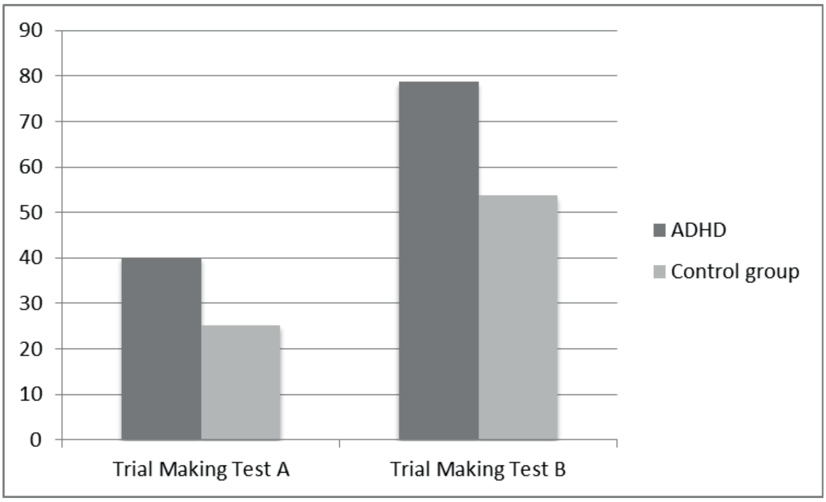

Fig. 4. Comparison of average times: Trial Making Test A and B

ferences were not found in terms of the number of mistakes made, as was the case in the first part of the task. The next step was to examine the validity of differences between the average in the performance time of the B and A version. The difference in terms of the ability to switch to a new criterion after learning one response principle was examined at the same time. The average difference of task performance in version A and B was 38.47 in the criterion group, and 28.47 in the control group. This difference is not significant from the statistical point of view.

RESULTS EVALUATION

The presented research included a wide range of attention and memory functioning in persons with hyperactivity symptoms. The research examined mainly the selective ability of attention, the ability to focus attention and the efficacy of perceptive field search. It turned out that persons with ADHD symptoms search in the same time significantly fewer elements in comparison to persons without such symptoms and, in consequence, make relatively more mistakes. These results are consistent with many others, which have proved that persons with ADHD symptoms make more mistakes during work, both in the form of false alarms as well as omissions (McLoughlin et al., 2010, 2011; Lundervolt et al., 2011; Avisar and Shalev, 2011). Our own test results confirm also that adults with hyperactivity symptoms have reduced abilities to focus attention. This is particularly visible when performing monotonous actions under time pressure, which is extremely tiring for persons with ADHD. Difficulties in maintaining attention were shown in the already cited studies by Lundervolt et al., (2011) or Marchetta et al., (2008). It is worth noticing that the differences proved in the research between the groups, may also result from the fact that persons with hyperactivity symptoms are likely to inaccurately estimate the time needed to carry out the task (Hallowell and Ratey, 2004).

The test results concerning the functioning of auditory and visual working memory obtained in the research herein presented are in accordance with the results cited in the literature (e.g. Walsh, 1998; Boonstra et al., 2005; Dowson et al., 2004; Marchetta et al., 2008; Miller et al., 2012). The revealed deficits in adults with ADHD symptoms concern both operating memory on visual material and memory based on phonological competence. With reference to Baddeley's concept (1993), it can be concluded that psychomotor hyperactivity involves dysfunctions in terms of the phonological loop and visual-spatial field.

The research objective was to answer the question of differences in terms of psychomotor speed and the ability to switch to a new criterion for response. Our own research results confirm partially previous reports on the worse psychomotor functioning of hyperactive persons (e.g. Miller et al., 2012). Our own research results are not consistent with those cited in the literature, concerning the abilities of adults with ADHD symptoms to switch to a new criterion during task performance. Literature reports suggest that persons with hyperactivity symptoms may have problems in terms of changing the way of responding (Pachalska et al., 2007; Miller et al., 2012; Łockiewicz et al., 2012). Our research results did not confirm these assumptions. The ability to change the principle according to which the task is performed is on the similar level in persons with ADHD symptoms as in healthy persons.

Summing up, with regard to attention functioning, persons with ADHD symptoms work on fewer elements in a given time, which indicates a slower course of search and selection processes. A conclusion may be drawn that in the contest between speed and correctness among persons with ADHD symptoms, correctness wins, because they do not make more mistakes in general. It proves that the deficiencies of selection effectiveness are compensated for by performance accuracy. A suggested compensation mechanism is confirmed by other cognitive functions research results. In terms of visual-spatial functions, persons with ADHD come out worse in terms of processing speed level, but not in terms of efficacy. They work longer, but the level of performance is similar to the one obtained by those without symptoms. In addition, persons with hyperactivity symptoms showed no deficits in terms of flexibility of the applicable rules and criteria. Working memory, both auditory and visual, functions poorer in this group in comparison to persons without symptoms. This constitutes difficulties in the current maintaining in consciousness and working out information regardless of the modality to which they are addressed.

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